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SUPPLY MULTIPLIERS IN A CENTRALLY PLANNED ECONOMY WITH A PRIVATE SECTOR *

by

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ABSTRACT

A simple model of a centrally planned economy is developed with a state sector and private sector, and with a supply constraint affecting state sector output. In such a model, a supply multiplier can be derived under the same conditions which would make an increase in state sector prices an effective means of reducing shortage. Moreover, a one-sector constrained equilibrium model of the state sector does not yield misleading results by ignoring the private sector; and the private sector price level is a reliable indicator of shortage in the economy.

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1. Introduction

It is well known by now that an economy facing a predominance of supply constraints can experience a supply multiplier analogous to the familiar Keynesian-type expenditure multiplier which occurs in a demand constrained economy. These phenomena are usually analysed in a highly aggregated model with fixed prices, a single output produced by labour, and money [e.g. see Malinvaud (1977), Barro and Grossman (1976), and on the supply multiplier itself, Barro and Grossman (1974)]. In such a simple model, it is no surprise to find that only a limited number of types of equilibrium are possible, depending on the constraints agents perceive in the goods and labour markets respectively. Thus in the case where firms do not hold output stocks, only three constrained equilibria can arise (i.e. in addition to the Walrasian equilibrium):

(a) Keynesian equilibrium

firms face demand constraints in the product market,

households face demand constraints in the labour market.

(b) Repressed inflation

firms face supply constraints in the labour market and households face supply constraints in the product market.

(c) Classical equilibrium

households face supply constraints in the product market and demand constraints in the labour market.

The object of this paper is to take up the story of the second type of equilibrium, repressed inflation, extending it to cover a centrally planned economy. However, the model needs some modifications, partly to take account of points raised by Kornai (1980) in his analysis of shortage conditions under central planning (but for a critical review of Kornai's analysis, see also Hare (1986)), and partly to disaggregate. The latter will enable us to distinguish between the state sector within which central planning prevails, and a presumably smaller, though more flexible, private sector. The reasons for doing this are twofold.

First, we can achieve somewhat greater realism: even in the most centralised economy, it is a serious mistake to imagine that the whole of production is always subject to the planners' dictates. There is always at least a small sphere of economic activity operating according to something approximating to normal market principles. Second, the resulting model will allow us to address and properly investigate, an intriguing remark in Nuti (1986, p. 69):

> 'Consumers are indeed quantity-rationed in the state sector but they are not subject individually to overall quantity constraints since they can always spend their money in the secondary market. It follows that the "supply multiplier", i.e. rounds of reduction in labour supply (and therefore consumer good supply) which are alleged as a consequence of quantity constraints, do not necessarily occur and can only be expected to be present in the same circumstances in which labour supply would respond negatively to open inflation.'

This comment formed part of an argument directed against some of the recent empirical work on Eastern Europe based on Barro-Grossman models (e.g. Portes (1984), Quandt et al (1987), Charemza and Gronicki (1984) and others). However, while Nuti's comment is formally correct, the argument as a whole is not as compelling as he would have us believe; this will become more apparent as our analysis proceeds.

In the next section, we set out a two sector model of a planned economy with private sector, to serve as the basis for the remainder of the paper. Normally, in these constrained equilibrium models, disaggregation leads to a multiplicity of types of equilibria which rapidly becomes too complicated to be of any general interest. However, in the model developed below I shall concentrate on just one equilibrium which is the one most likely to be observed. Section three then studies the comparative statics of the model for a special, more tractable case. It turns out that supply multipliers do not always arise, as indicated by Nuti, but that when they do, the link with the open inflation case

is precisely as he asserts; moreover in the specific model studied in detail, their magnitude is unaffected by the presence of the private sector. Consequently an approximation to the model which ignores the private sector is not likely to be as misleading as Nuti argues. Because of this, the empirical work he attacks cannot be regarded as fatally flawed, at least not on this account. Of course, it may still be vulnerable to attacks from other standpoints, such as Kornai (1980), but that would take us beyond the scope of the present paper.

2. Two sector model of a planned economy

We begin with the state sector of the economy. This sector is assumed to produce a single output, y_1, using labour, L_1, according to the standard, concave production function,

$$y_1 = f_1(L_1) \qquad (1)$$

The price of state output, p_1, and the wage rate received by the labour force employed in the state sector, w_1, are both assumed to be given and fixed. As is usual in centrally planned economies, the profits accruing from state production,

$$\pi_1 = p_1 y_1 - w_1 L_1 \qquad (2)$$

are assumed to be paid directly into the state budget. Since we do not subsequently discuss the budget, or the state's financial balances in general, this means that these profits play no part in the subsequent analysis. While clearly unsatisfactory in anything other than a short-run model, this approach is essentially the same as that employed in Malinvaud (1977). It is therefore subject to the same limitations, though convenient for the present analysis.

In the current plan period, we suppose that the planners require output Z_1 for investment, exports, etc. Hence, the state output available for private consumption, $x_1 = y_1 - Z_1$. Note that it is not appropriate to make an assumption concerning profit maximisation in the state sector, though in order to make use of production functions in a sensible way it is necessary to postulate that firms do at least seek to minimise costs. Problems of ensuring this in a centrally planned economy take us well beyond the scope of this paper.

Turning to the <u>private sector</u>, this, too produces a single output, y_2, using labour L_2, according to the well-behaved production function,

$$y_2 = f_2(L_2) \qquad (3)$$

Output price, p_2, and wage rate, w_2, for this sector will subsequently be determined by market clearing conditions. But the sector should be thought of as being composed of numerous small firms behaving competitively. Hence at (p_2, w_2), demand for labour in the private sector will be determined by the usual condition:

$$w_2 = p_2 \frac{\partial f_2}{\partial L_2} \tag{4}$$

Unlike in the state sector, private sector profits,

$$\pi_2 = p_2 y_2 - w_2 L_2 \tag{5}$$

are entirely a contribution to private sector income. This means that we ignore any taxation of private profits. However, in most socialist countries such taxation is small or negligible and in any case it is clear that a great deal of private income would never be adequately reported to the authorities. Nevertheless, the addition of taxation to the model is easily done, though it has no effect on the principal results reported below. Also, it would not be difficult to model the private sector somewhat differently, essentially as a mechanism through which part of state output is resold at a price above the official state price, the profits accruing to the traders concerned. But that approach is not pursued in this paper.

So much for the supply side of the economy. Let us now consider demand, in particular consumers' demand for goods and services, and the supply of labour to both sectors. We model this by treating the demand side of the economy as if it were the result of utility maximisation by a single household. This implies, of course, that any distributional considerations are completely neglected, but these are unlikely to be crucial for the present discussion. Accordingly, we begin with a strictly concave utility function of the following form:

$$u = u(c_1, c_2, \bar{L}_1 - L_1, \bar{L}_2 - L_2, m) \qquad (6)$$

where c_1, c_2 are the consumption of state and private sector output respectively; L_1 and L_2 have already been defined and $\bar{L}_1$, $\bar{L}_2$ are the maximum amounts of labour which could be supplied; and m is the stock of money which the household sector wishes to carry forward into the next period (this is a standard device to make it possible to compress a multi-time period model into a single period, to simplify analysis; the technical details of the procedure need not detain us). It might be thought that a more appropriate formulation of $u(\cdot)$ would replace the arguments $\bar{L}_1 - L_1$, $\bar{L}_2 - L_2$ in (6) with the single argument $(\bar{L} - L_1 - L_2)$. However, in practice the two types of labour are not perfect substitutes. To a large extent they are supplied by different people, though some people work in both sectors; and for many, a state sector job is

essential to secure access to state benefits etc., which are not formally modelled here. The aggregation implicit in (6) completely masks such detail.

The household sector maximises (6) subject to a budget constraint, and subject to any other constraints on feasible transactions. The budget constraint assumes the form:

$$p_1c_1 + p_2c_2 + m = w_1L_1 + w_2L_2 + \pi 2 + M \qquad (7),$$

where M is the initial stock of money holdings and other notation has all been defined above. Equality can be assumed in (7) provided that $u(\cdot)$ has the property of non-satiation.

Up to this point, the treatment of the household sector is entirely conventional. In particular, maximising (6) subject only to (7) yields a demand function for state sector output of the form:

$$c_1 = d_1 (p_1, p_2, w_1, w_2, \pi_2 + M) \qquad (8)$$

and a corresponding labour supply function to the state sector:

$$L_1 = s_1 (p_1, p_2, w_1, w_2, \pi_2 + M) \qquad (9)$$

Similar equations can be obtained for the private sector:

$$c_2 = d_2 (p_1, p_2, w_1, w_2, \pi 2 + M) \quad \}$$
$$L_2 = s_2 (p_1, p_2, w_1, w_2, \pi 2 + M) \quad \} \qquad (10)$$

Equilibrium values for p_2 and w_2 can then be obtained from (4), together with the market clearing condition:

$$c_2 = f_2(L_2) \qquad (11),$$

where c_2 and L_2 are as specified in (10). Let the equilibrium values of p_2 and w_2 be p_2^* and w_2^*. Inserting these values into (8) and (9) (including in π_2) gives us levels of consumption of state sector output, and labour supply to the state sector, which we denote by (c_1^*, L_1^*). Let us now make the following

:

Assumption $\quad f_1(L_1^*) < c_1^* + Z_1$

A number of separate conditions are implicit in this simple statement. First, there is no direction of labour, so the state sector can employ no more than the available labour supply L_1^*, hence $f_1(L_1^*)$ is the maximum level of output which the state sector can supply. Second, this supply is insufficient to meet the forthcoming demand, either because p_1 is too low in relation to w_1 or because Z_1 is too large in relation to total output, or some combination of the two. From observation of the centrally

planned economies over a long period, it is clear that this reflects the real situation for much of the time. Kornai (1980) goes further than this, to argue that such shortage is endemic.

The important implication of the above assumption is that some demands placed on the economy cannot be fulfilled. In the short run analysis which is my principal concern, I assume that the planners adjust neither p_1 nor w_1, nor Z_1, so that all the adjustment is borne by households, or occurs within the private sector. Later on, we shall examine the impact of varying these parameters. The household sector's optimisation problem, therefore, takes the following constrained form:

$$\left.\begin{array}{l} \text{Max } u(c_1, c_2, L_1-L_1, L_2-L_2, m) \\ \{c_1,c_2,L_1,L_2, m\} \\ \text{subject to: } p_1c_1 + p_2c_2 + m = w_1L_1 + w_2L_2 + \pi_2 + M \\ \text{and also: } c_1 = f_1(L_1) - Z_1 \end{array}\right\} \quad (12)$$

By assumption, both constraints in (12) are binding, and we know that the solution should be characterised by $c_1 < c_1^*$ and presumably also by $L_1 < L_1^*$. As before, once this has been solved, the equilibrium values of p_2 and w_2 are found by imposing the conditions (4) and (10). This completes the general statement of our model; let us now investigate some of its properties.

3. Comparative Statics

To make further progress it is simplest to work in terms of a special case. The most convenient functional forms for our purposes are the following:

(a) Linear production functions:

$$\left.\begin{aligned} y_1 &= a_1 L_1 \\ y_2 &= a_2 L_2 \end{aligned}\right\} \qquad (13)$$

(13) ensures that in equilibrium, the private sector will yield no profits, i.e. $\pi_2 = 0$.

(b) Linear expenditure system, based on the utility function:

$$u = \alpha_1 \ln(c_1 - \gamma_1) + \alpha_2 \ln(c_2 - \gamma_2) + \beta_1 \ln(\bar{L}_1 - L_1) + \beta_2 \ln(\bar{L}_2 - L_2) + \delta \ln(m) \qquad (14),$$

where it is helpful to assume that $(\alpha_1+\alpha_2) + (\beta_1+\beta_2) + \delta = 1$

Maximising (14) subject to the budget constraint, (7), yields the solution:

$$\left.\begin{aligned} c_1 &= \gamma_1 + \frac{\alpha_1}{p_1} N \\ c_2 &= \gamma_2 + \frac{\alpha_2}{p_2} N \\ L_1 &= \bar{L}_1 - \frac{\beta_1}{w_1} N \\ L_2 &= \bar{L}_2 - \frac{\beta_2}{w_2} N \\ \text{and} \quad m &= \delta N \end{aligned}\right\} \qquad (15)$$

where supernumerary income, $N = (M + w_1\bar{L}_1 + w_2\bar{L}_2 - p_1Y_1 - p_2Y_2)$ (16)

(we have incorporated $\pi_2 = 0$ into (16)).

Equilibrium in the private sector is achieved by imposing conditions (4) and (10), which now take the form:

$$w_2 = a_2p_2 \tag{17}$$

and

$$c_2 = a_2L_2$$

i.e. $$Y_2 + \frac{\alpha_2}{p_2}.N = a_2\left(\bar{L}_2 - \frac{\beta_2}{w_2}.N\right) \tag{18}$$

After some manipulation, it is straightforward to show that

$$p_2^* = \frac{(\alpha_2 + \beta_2)}{1-(\alpha_2 + \beta_2)} \cdot \left(\frac{N_1}{(a_2\bar{L}_2 - Y_2)}\right) \tag{19}$$

where $N_1 = M + w_1\bar{L}_1 - Y_1p_1$; the corresponding value of w_2^* then follows from (17). Hence

$$C_1^* = Y_1 + \frac{\alpha_1}{p_1}\left(\frac{N_1}{(1-(\alpha_2 + \beta_2))}\right) \tag{20}$$

and $$L_1^* = \bar{L}_1 - \frac{\beta_1}{w_1}\left(\frac{N_1}{(1-(\alpha_2 + \beta_2))}\right) \tag{21}$$

Notice that in this simple example, the effect of the private sector on the demand for state sector output, and on the supply of labour to the state sector, only operates through the two parameters α_2 and β_{i2}. This would not remain the case in more general specifications.

The fundamental assumption introduced earlier now takes the special form:

$$a_1 L_1^* < c_1^* + Z_1 \qquad (22),$$

and we now examine the consequences of imposing this assumption on the above specification.

The simplest procedure is to start by maximising (14) with the additional constraint $c_1 = x_1$ ($< c_1^*$, by assumption), which we can do provided, of course, that $x_1 > \gamma_1$. The solution is the following:

$$\left.\begin{aligned} c_1 &= x_1 \\ c_2 &= \gamma_2 + \frac{\alpha_2^1}{p_2}.\, N^1 \\ L_1 &= \bar{L}_1 - \frac{\beta_1^1}{w_1}.\, N^1 \\ L_2 &= \bar{L}_2 - \frac{\beta_2^1}{w_2^1}.\, N^1 \\ \text{and} \quad m &= \delta^1 N^1 \end{aligned}\right\} \qquad (23)$$

where $\alpha_2^1 = \alpha_2 / (\alpha_2 + \beta_1 + \beta_2 + \delta)$ and similarly for β_1^1, β_2^1, and δ^1;

and $N^1 = (M + w_1\bar{L}_1 + w_2\bar{L}_2 - p_1x_1 - p_2Y_2)$ (24)

Then, for the given level of x_1, equilibrium in the private market yields an equation for p_2 identical to (19), except that (α_2^1, β_2^1 and N_1^1) replace (α_2, β_2, N_1), where $N_1^1 = M + w_1\bar{L}_1 - p_1x_1$. Making the same substitution in (21) then yields the new supply of labour to the state sector, given the constraint on c_1. Finally, we use the state sector goods market balance, in the form $x_1 = a_1L_1 - Z_1$, to determine the equilibrium value for the constraint on consumption of state output, x_1. The solution makes economic sense provided that

$$\frac{w_1}{p_1} > \frac{a_1\beta_1}{\beta_1+\delta} = \lambda \qquad (25),$$

where λ is used to denote the right hand side, in which case the solution is:

$$c_1 = x_1 = \frac{a_1(\delta\bar{L}_1w_1 - \beta_1M) - Z_1w_1(\beta_1 + \delta)}{w_1(\beta_1 + \delta) - p_1a_1\beta_1} \qquad (26)$$

Given (26), the rest of the solution is easily calculated, so there is no need to write it down here. In any case, (26) is what we need to derive the comparative statics that are of greatest interest, together with the equations describing equilibrium in

the private sector of our model economy [esp. (19) amended to replace (α_2, β_2, N_1) with α_2^1, β_2^1 and N_1^1, and using the value of x_1 from (26)].

Supply multiplier

$$\text{From (26)}, \quad \frac{dc_1}{dZ_1} = -\frac{1}{1 - \lambda p_1/w_1} \tag{27}$$

Thus a unit increase in the state's requirement for final output, Z_1, reduces private consumption of state output (in the new constrained equilibrium) by the amount indicated in (27). This is a multiple of the original change in Z_1, so it follows that state output as a whole actually falls. Specifically,

$$\frac{dy_1}{dZ_1} = 1 - \frac{1}{1 - \lambda p_1/w_1} = -\frac{\lambda p_1/w_1}{1 - \lambda p_1/w_1} \tag{28}$$

By the same token, equilibrium labour supply to the state sector also declines. Note, however, that these results do not depend at all on the behaviour of the private sector except to the extent that the existence or otherwise of the sector might affect the parameter, λ. However, it is hard to see why there should be any such effect, since λ depends only on labour productivity in the state sector and a ratio of utility function parameters.

Naturally, despite that fact that the presence of the private sector does not influence the magnitude of the state sector supply multiplier, the tightening of supply constraints in the state sector (i.e. raising Z_1) does affect private sector production. In particular, it is easy to show that:

$$\frac{dw_2}{dZ_1} = a_2 \frac{dp_2}{dZ_1} = -\frac{p_1 p_2}{N_1^1} \cdot \frac{dc_1}{dZ_1} > 0 \qquad (29)$$

$$\frac{dc_2}{dZ_1} = a_2 \frac{dL_2}{dZ_1} = \frac{\partial c_2}{\partial p_2} \cdot \frac{dp_2}{dZ_1} + \frac{\partial c_2}{\partial x_1} \cdot \frac{dc_1}{dZ_1}$$

$$= \frac{-\alpha_2^1 p_1}{a_2 p_2 N_1^1} [(1 + a_2)N_1^1 + w_2 L_2]. \frac{dc_1}{dZ_1} > 0 \qquad (30)$$

Hence the equilibrium price and wage in the private sector both rise, and output and employment also increases. Since the ratio w_2/p_2 is unchanged, it is clear that all workers experience a fall in their real income, a fall that is most pronounced for those employed wholly in the state sector (this remark abstracts from the one household assumption employed in the formal analysis). Intuitively, since state output has become relatively more 'scarce', one might have expected its relative price to rise. However, to restore equilibrium requires a fall in the real wage and with p_1, w_1 fixed, the only way in which this can occur in the model is via an increase in p_2.

Two observations can be made at this point. First, the results obtained imply that a conventional, one sector, constrained equilibrium model of the state sector of this economy will not yield misleading results. The presence of the private sector

simply doesn't matter from this point of view. Second, the monotonic relationship between Z_1 and p_2 means that we can make correct inferences about the degree of shortage in this economy simply by studying p_2 or, equivalently, the ratio p_2/p_1, as is commonly done.

Suppose, now, that the planners permitted open inflation, in the sense that they allowed p_1 to increase, presumably in the hope of choking off some of the excess demand for state sector output. From (26), it is straightforward to derive the effect of an increase in the price of state sector output, p_1, on equilibrium consumption:

$$\frac{1}{c_1}\frac{dc_1}{dp_1} = \frac{\lambda}{w_1 - p_1\lambda} > 0 \qquad (31),$$

provided that (25) holds. Hence, just as Nuti asserted (see quote in introduction), permitting an increase in p_1, is effective in exactly the same circumstances as those in which a well-defined supply multiplier can be obtained.

$$\frac{1}{p_1c_1} \cdot \frac{d}{dp_1}(p_1c_1) = \frac{w_1}{p_1(w_1 - p_1\lambda)} > 0 \qquad (32),$$

from which it follows that as p_1 increases, N^1 and $N_1{}^1$ decline, and p_2 also falls (therefore so does w_2); c_2 and L_2 can either increase or decrease, depending on the precise specification of parameters.

These last results can be interpreted quite simply. First, the increase in p_1 reduces c_1^* and increases L_1^* (from (20) and (21), hence reducing the imbalance in the market for state sector output as measured by the conventional Walrasian demand and labour supply functions. The initially increased willingness to supply labour to the state sector then translates into an actual increase in labour supply, and a corresponding increase in equilibrium output, when the supply constraint which consumers still face is properly allowed for. Evidently the gaps between c_1 and c_1^*, and L_1 and L_1^* both decline, another indication that the planners get closer to the Walrasian equilibrium when they allow p_1 to increase. Finally, what happens in the private sector is less clear cut: although equilibrium price and wage rate certainly fall, output can move in either direction. Moreover, the effect on real wages is also unclear.[i]

4. Conclusion

The model we have developed shows that the addition of a private sector to a model of a centrally planned economy in which consumers face supply constraints from the state sector is an interesting and useful exercise. Nuti's assertion is justified, and some additional results are also obtained. In particular, a one sector, constrained equilibrium model of the state sector will not necessarily yield misleading results by ignoring the private

sector; and movements in the private sector price level give us a reliable guide to the degree of shortage experienced in the state sector of the economy.

Strictly speaking, the case analysed here is not identical to that considered by Nuti. Whereas we have modelled a separate private sector, Nuti is also concerned with the situation where there is a 'secondary market' in state sector output, in which part of such output is retraded at (presumably) higher prices. However, it is not difficult to extend the above analysis to cover this case (e.g. by allowing the private sector a second, retrading activity; though with strict limits on the volume of business, partly to avoid collapse of the model to the market equilibrium solution, partly to reflect real controls imposed by the central planners), and the general conclusions summarised above are not materially changed.

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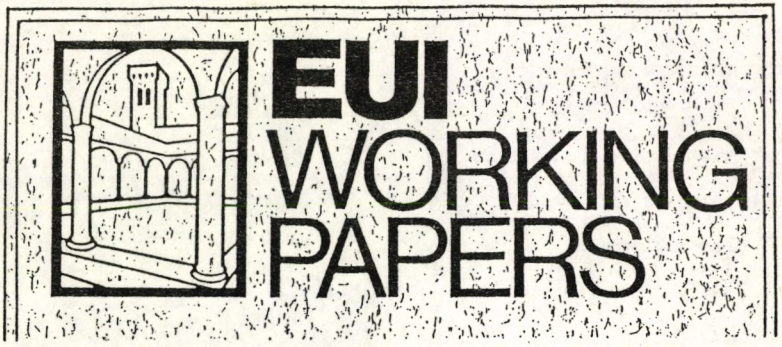

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